chapter 14

MP3 Speciation tutorial transcript

In the arid plains of southeast Colorado, a small river has carved an isolated canyon known as Picketwire. Far back in the canyon, erosion by the river has exposed a narrow shelf of rock about a quarter mile long. Getting there is difficult, but those that make the journey are not just traveling to a remote and beautiful area. They are also making a journey back in time. You see, the shelf of rock exposed by the river was once the muddy shores of a lake. Recorded on those once-muddy shores are hundreds of dinosaur tracks. In Picketwire you have a window into Earth's history, a history dominated by organisms that are now extinct. Colorado is a state rich in fossil deposits like Picketwire that provide us with clues and evidence about Earth's history. Written in fossils, the story of life is a recurring story of extinction events in which large numbers of organisms disappeared from the fossil record followed by the appearance of new forms of organisms.

How do new species arise? This is called macroevolution—the evolution of species. Charles Darwin's theory of natural selection provided the framework of an answer to that question. But can the small changes from generation to generation, typical of evolution by natural selection, account for the large differences that we see between species or between groups of species? The short answer is yes and in this MP3 tutorial we will explore how speciation occurs.

Let's begin with a difficult task: defining just what a species is. Biologists have struggled with this for years and probably will continue to. Intuitively, it sounds easy. Everyone can tell the difference between a lion and a tiger or a wolf, right? True enough for some groups, but for others it is not so easy. Here's an example. Kansas, Montana, Nebraska, North Dakota, Oregon, and Wyoming have all designated the western Meadowlark as their state bird. In Kansas, Nebraska, and North Dakota, there is another Meadowlark, the eastern Meadowlark. The eastern looks just like the western with some minor differences, yet they are classified as two different species. Why is that? It turns out that their songs are significantly different and the two populations rarely interbreed. By not breeding together their two gene pools (the population's collective genes) are isolated from each other. They are reproductively isolated. This is actually one of the main ways that biologists designate species. It is called the biological species concept and can be stated as this: A species is a population of organisms that under natural conditions are able to mate and produce fertile offspring. This definition often works well, but it cannot be applied to all organisms. For example, it doesn't work for asexual organisms, prokaryotes, or extinct fossil organisms.

The reproductive isolation that characterizes a distinct species can arise many different ways. In the case of the meadowlarks, the two types are isolated by a behavioral mechanism—their ability to sing a particular song. Other species, such as eastern and western spotted skunks, breed at different times of the year, a reproductive barrier called temporal isolation. In some insect species, the male and female genitalia fit together like a lock and key. Those with the wrong key cannot mate. This is termed mechanical isolation. These three mechanisms just mentioned—behavioral, temporal, and mechanical—all prevent mating. Other types of isolating mechanisms operate after mating takes place. For example, some fertilized eggs may not be able to successfully complete mitosis. Other times, members of different species can mate, but the resulting hybrid will be sterile or otherwise unfit. Check your text for more examples of isolating mechanisms.

How do reproductive isolations develop? Usually before populations become reproductively isolated, they first become geographically isolated. The earth is constantly changing. When it does, populations are sometimes split and isolated from each other. For example, 12,000 years ago, a glacier covered much of North America. This glacier most assuredly isolated meadowlark populations from each other. Each isolated population continued to adapt through natural selection to its particular environment. The result was that when the glaciers retreated, and the meadowlark

populations once again came into contact with each other, changes in mating behavior limited eastern and western interbreeding. This is macroevolution, the origin of new species. It's important to note that some bird populations in that region developed into new species but others did not.

Islands are another isolating mechanism. The islands of Cape Verde, the Falklands, Galapagos, Tahiti, and New Zealand all inspired Darwin with their unique flora and fauna. Each of these islands had plants and animals similar to, yet distinct from, continental varieties. On the Galapagos Islands, for example, there are 17 species of finches. These 17 different species evolved from one mainland species that reached the island chain early in its history and found numerous habitats empty of competitors.

Islands don't even have to be land masses surrounded by water. For example, mountains separated by large stretches of desert have cool and moist mountain tops. Each mountain top is isolated from the others by the desert, so species adapt there in isolation from other nearby species.

Speciation takes a long time in human terms. For years, most biologists thought as Darwin had that any significant changes—especially changes that lead to new species—would not be measurable in a human life time. Today, researchers are working on a number of experimental models for evolution. Scientists are raising stickleback fish in controlled environments, predicting and observing changes in fish populations as portions of the population specialize to different environments. Long-term studies of the Galapagos finches have measured rates of evolution faster than thought possible for vertebrates. And labs all over the country continue to design evolutionary experiments with populations of fruit flies and E. coli bacteria. Keep your eyes out this school year for science news. You'll see headlines that announce new findings that continue to support and illuminate evolutionary theory.

I hope this tutor session has helped you understand how Darwin's theory accounts for the development of new species. Please consult your book and lecture notes for further discussion, and good luck with your studies!

Test Your Knowledge

1. A biologist spends her summer break collecting frogs from a remote jungle in Peru. She discovers two distinct color forms that could be variants of a single species or two different species. What would be the most direct test of their species status under the biological species concept?

   A) Compare the color patterns of the two groups. If they are distinct enough, the two forms belong to different species
   B) Observe mating in the natural environment of the two groups. If the two forms do not mate with each other, they are different species.
   C) Compare the habitat use of the two groups. If they use different habitats, they must be different species
   D) Compare the DNA of the two groups. If their genes are different, they must be different species.

2 . In _____ isolation, it is physically impossible for two species to mate with each other, often because their genitalia do not fit together properly.

A) Behavioral B) Temporal C) Mechanical D) Habitat

3 . Eastern and western spotted skunks breed at different times of the year. Therefore, they are prevented from interbreeding by _____ isolation.

A) Behavioral B) Temporal C) Mechanical D) Habitat

4 . The process of speciation starts with a single species. It often involves the following steps: (1) two populations become physically separated from one another by a barrier to dispersal and stop exchanging genes; (2) the populations experience independent evolutionary changes; (3) changes in one or both populations result in development of reproductive isolating mechanisms that prevent interbreeding; further changes in geography may bring the groups back into contact. When do you officially have two separate species?

A) Step 1 B) Step 2 C) Step 3 D) None of the above

5 . Darwin thought that significant evolution was much too slow to be witnessed in a human lifetime. Recent experiments by biologists have _____.

A) Confirmed Darwin's View
B) indicated that evolution takes place extremely quickly; in fact, individuals can evolve to become new species within their life spans
C) shown that evolutionary change takes even longer than Darwin imagined
D) shown that some populations can evolve quite rapidly, with important changes occurring over several generations in the laboratory